AMENDMENTS TO THE CLAIMS

Please amend the claims as set forth hereinbelow.

1.-20. **(cancelled)**

21. **(currently amended)** An optical apparatus, comprising:
a semiconductor device substrate;
a semiconductor optical device formed on the device substrate and including a device waveguide segment terminating at a device end face; [[and]]
an end-coupled planar optical waveguide formed on the device substrate at the device end face and end-coupled at its proximal end to the device waveguide through the device end face, the end-coupled waveguide including a waveguide core and waveguide cladding; and
a reflective coating formed between the device substrate and at least a portion of the end-coupled waveguide.

22. **(original)** The apparatus of Claim 21, wherein the reflective coating comprises a metallic coating.

23. **(original)** The apparatus of Claim 21, wherein the reflective coating comprises a dielectric coating.

24. **(original)** The apparatus of Claim 21, wherein the end-coupled waveguide comprises a low-index planar optical waveguide.

25.-33. **(cancelled)**

34. **(original)** An optical apparatus, comprising:
a semiconductor device substrate;
a semiconductor optical device formed on the device substrate and including a device waveguide segment terminating at a device end face; and
an end-coupled planar optical waveguide formed on the device substrate at the device end face and end-coupled at its proximal end to the device waveguide through the device end face, the end-coupled waveguide including a waveguide core and waveguide cladding,

wherein at least a portion of the device end face is curved in at least one dimension.

35. **(original)** The apparatus of Claim 34, wherein the curved portion of the end face is convex.

36. **(original)** The apparatus of Claim 34, wherein the curved portion of the end face serves to increase reflective optical coupling of a device optical mode back into the device waveguide segment, relative to a substantially flat device end face.

37. **(original)** The apparatus of Claim 34, wherein the curved portion of the end face serves to increase optical end-coupling between the device waveguide segment and the end-coupled waveguide, relative to a substantially flat device end face.

38. **(original)** The apparatus of Claim 34, wherein the curved portion of the end face is limited in transverse extent so as to suppress higher-order device optical modes.

39. **(original)** The apparatus of Claim 34, wherein the end-coupled waveguide comprises a low-index planar optical waveguide.

40. **(original)** An optical apparatus, comprising:

a semiconductor device substrate;

a semiconductor optical device formed on the device substrate and including a device waveguide segment terminating at a device end face; and

an end-coupled planar optical waveguide formed on the device substrate at the device end face and end-coupled at its proximal end to the device waveguide through the device end face, the end-coupled waveguide including a waveguide core and waveguide cladding,

wherein:

the device end face includes an outwardly protruding portion extending along the substrate from a bottom portion of the device end face beneath a proximal portion of the end-coupled waveguide; and

at least one layer of the end-coupled waveguide decreases in thickness toward the end face, the outwardly protruding portion of the device waveguide and the

decreasing layer thickness together yielding a desired layer surface profile for at least one layer of the end-coupled waveguide.

41. **(original)** The apparatus of Claim 40, wherein a lower cladding layer of the end-coupled waveguide decreases in thickness toward the end face, the outwardly protruding portion of the device waveguide and the decreasing lower cladding layer thickness together yielding a substantially flat upper surface of the lower cladding layer above the protruding portion of the device waveguide.

42. **(original)** The apparatus of Claim 40, wherein a lower cladding layer of the end-coupled waveguide decreases in thickness toward the end face, the outwardly protruding portion of the device waveguide and the decreasing lower cladding layer thickness together serving to position a proximal end of a core of the end-coupled waveguide for optical end-coupling with the optical device.

43. **(original)** The apparatus of Claim 40, wherein the end-coupled waveguide comprises a low-index planar optical waveguide.

44.-63. **(cancelled)**

64. **(original)** A method, comprising:

forming a semiconductor optical device on a device substrate, the optical device including a device waveguide segment terminating at a device end face;

depositing waveguide cladding material on the substrate so as to form a waveguide lower cladding layer;

depositing waveguide core material over the lower cladding layer so as to form a waveguide core;

depositing waveguide cladding material over the waveguide core material and the lower cladding layer so as to form a waveguide upper cladding layer, thereby forming an end-coupled planar optical waveguide on the device substrate end-coupled at its proximal end to the device waveguide through the device end face, the end-coupled waveguide comprising the lower cladding layer, the waveguide core, and the upper cladding layer; and

forming a reflective coating between the device substrate and at least a portion of the end-coupled waveguide.

65. **(original)** The method of Claim 64, wherein the reflective coating comprises a metallic coating.

66. **(original)** The method of Claim 64, wherein the reflective coating comprises a dielectric coating.

67. **(original)** The method of Claim 64, wherein the end-coupled waveguide comprises a low-index planar optical waveguide.

68.-76. **(cancelled)**

77. **(original)** A method, comprising:

forming a semiconductor optical device on a device substrate, the optical device including a device waveguide segment terminating at a device end face;

depositing waveguide cladding material on the substrate so as to form a waveguide lower cladding layer;

depositing waveguide core material over the lower cladding layer so as to form a waveguide core; and

depositing waveguide cladding material over the waveguide core material and the lower cladding layer so as to form a waveguide upper cladding layer, thereby forming an end-coupled planar optical waveguide on the device substrate end-coupled at its proximal end to the device waveguide through the device end face, the end-coupled waveguide comprising the lower cladding layer, waveguide core, and the upper cladding layer,

wherein at least a portion of the device end face is curved in at least one dimension.

78. **(original)** The method of Claim 77, wherein the curved portion of the end face is convex.

79. **(original)** The method of Claim 77, wherein the curved portion of the end face serves to increase reflective optical coupling of a device optical mode back into the device waveguide segment, relative to a substantially flat device end face.

80. **(original)** The method of Claim 77, wherein the curved portion of the end face serves to increase optical end-coupling between the device waveguide segment and the end-coupled waveguide, relative to a substantially flat device end face.

81. **(original)** The method of Claim 77, wherein the curved portion of the end face is limited in transverse extent so as to suppress higher-order device optical modes.

82. **(original)** The method of Claim 77, wherein the end-coupled waveguide comprises a low-index planar optical waveguide.

83. **(original)** A method, comprising:

forming a semiconductor optical device on a device substrate, the optical device including a device waveguide segment terminating at a device end face;

depositing waveguide cladding material on the substrate so as to form a waveguide lower cladding layer;

depositing waveguide core material over the lower cladding layer so as to form a waveguide core; and

depositing waveguide cladding material over the waveguide core material and the lower cladding layer so as to form a waveguide upper cladding layer, thereby forming an end-coupled planar optical waveguide on the device substrate end-coupled at its proximal end to the device waveguide through the device end face, the end-coupled waveguide comprising the lower cladding layer, waveguide core, and the upper cladding layer,

wherein:

the device end face includes an outwardly protruding portion extending along the substrate from a bottom portion of the device end face beneath a proximal portion of the end-coupled waveguide; and

at least one layer of the end-coupled waveguide decreases in thickness toward the end face, the outwardly protruding portion of the device waveguide and the decreasing layer thickness together yielding a desired layer surface profile for at least one layer of the end-coupled waveguide.

84. **(original)** The method of Claim 83, wherein a lower cladding layer of the end-coupled waveguide decreases in thickness toward the end face, the outwardly protruding portion of the device waveguide and the decreasing lower cladding layer thickness together yielding a substantially flat upper surface of the lower cladding layer above the protruding portion of the device waveguide.

85. **(original)** The method of Claim 83, wherein a lower cladding layer of the end-coupled waveguide decreases in thickness toward the end face, the outwardly protruding portion of the device waveguide and the decreasing lower cladding layer thickness together serving to position a proximal end of a core of the end-coupled waveguide for optical end-coupling with the optical device.

86. **(original)** The method of Claim 83, wherein the end-coupled waveguide comprises a low-index planar optical waveguide.

87. **(new)** The apparatus of Claim 21, wherein a proximal portion of the end-coupled waveguide includes a) waveguide cladding material between the device end face and a proximal end of the waveguide core, or b) waveguide core material on the device end face extending upward from the waveguide core away from the substrate.

88. **(new)** The apparatus of Claim 21, further comprising an optical coating formed between the device end face and the end-coupled waveguide.

89. **(new)** The apparatus of Claim 21, wherein the end-coupled waveguide includes a dual-core segment.

90. **(new)** The apparatus of Claim 21, wherein the device end face is non-normal with respect to optical propagation along the device waveguide segment.

91. **(new)** The apparatus of Claim 34, wherein a proximal portion of the end-coupled waveguide includes a) waveguide cladding material between the device end face and a proximal end of the waveguide core, or b) waveguide core material on the device end face extending upward from the waveguide core away from the substrate.

92. **(new)** The apparatus of Claim 34, further comprising an optical coating formed between the device end face and the end-coupled waveguide.

93. **(new)** The apparatus of Claim 34, wherein the end-coupled waveguide includes a dual-core segment.

94. **(new)** The apparatus of Claim 34, wherein the device end face is non-normal with respect to optical propagation along the device waveguide segment.

95. **(new)** The apparatus of Claim 40, wherein a proximal portion of the end-coupled waveguide includes a) waveguide cladding material between the device end face and a proximal end of the waveguide core, or b) waveguide core material on the device end face extending upward from the waveguide core away from the substrate.

96. **(new)** The apparatus of Claim 40, further comprising an optical coating formed between the device end face and the end-coupled waveguide.

97. **(new)** The apparatus of Claim 40, wherein the end-coupled waveguide includes a dual-core segment.

98. **(new)** The apparatus of Claim 40, wherein the device end face is non-normal with respect to optical propagation along the device waveguide segment.

99. **(new)** An optical apparatus, comprising:

a semiconductor device substrate;

a semiconductor optical device formed on the device substrate and including a device waveguide segment terminating at a device end face; and

an end-coupled planar optical waveguide formed on the device substrate at the device end face and end-coupled at its proximal end to the device waveguide through the device end face, the end-coupled waveguide including a waveguide core and waveguide cladding,

wherein:

the proximal portion of the end-coupled waveguide includes waveguide cladding material between the device end face and the proximal end of the waveguide core;

the waveguide cladding material between the device end face and the proximal end of the waveguide core forms a multimode waveguide segment; and

the waveguide core supports an optical mode substantially spatial-mode-matched with an optical mode supported by the device waveguide segment, and the length of the multimode waveguide segment is chosen so as to result in substantially spatial-mode-matched end-coupling between the device waveguide segment and the portion of the end-coupled waveguide that includes the waveguide core.

100. **(new)** An optical apparatus, comprising:

a semiconductor device substrate;

a semiconductor optical device formed on the device substrate and including a device waveguide segment terminating at a device end face; and

an end-coupled planar optical waveguide formed on the device substrate at the device end face and end-coupled at its proximal end to the device waveguide through the device end face, the end-coupled waveguide including a waveguide core and waveguide cladding,

wherein:

the proximal portion of the end-coupled waveguide includes waveguide cladding material between the device end face and the proximal end of the waveguide core;

the waveguide cladding material between the device end face and the proximal end of the waveguide core forms a multimode waveguide segment; and

the waveguide core supports an optical mode larger than an optical mode supported by the device waveguide segment, and the length of the multimode waveguide segment is chosen so that it functions as a mode expander for end-coupling the device waveguide segment and the end-coupled waveguide.

101. **(new)** The method of Claim 64, wherein:

the deposited cladding material substantially covers the device end face; and

the deposited waveguide core material extends upward from a proximal end of the waveguide core away from the substrate.

102. **(new)** The method of Claim 64, further comprising forming an optical coating between the device end face and the end-coupled waveguide.

103. **(new)** The method of Claim 64, wherein the end-coupled waveguide includes a dual-core segment.

104. **(new)** The method of Claim 64, wherein the device end face is non-normal with respect to optical propagation along the device waveguide segment.

105. **(new)** The method of Claim 64, wherein multiple optical devices are formed concurrently on a common device substrate wafer, and multiple corresponding

end-coupled waveguides are formed concurrently on the common substrate wafer, and further comprising dividing the common substrate wafer into multiple device substrates.

106. **(new)** The method of Claim 77, wherein:
the deposited cladding material substantially covers the device end face; and
the deposited waveguide core material extends upward from a proximal end of the waveguide core away from the substrate.

107. **(new)** The method of Claim 77, further comprising forming an optical coating between the device end face and the end-coupled waveguide.

108. **(new)** The method of Claim 77, wherein the end-coupled waveguide includes a dual-core segment.

109. **(new)** The method of Claim 77, wherein the device end face is non-normal with respect to optical propagation along the device waveguide segment.

110. **(new)** The method of Claim 77, wherein multiple optical devices are formed concurrently on a common device substrate wafer, and multiple corresponding end-coupled waveguides are formed concurrently on the common substrate wafer, and further comprising dividing the common substrate wafer into multiple device substrates.

111. **(new)** The method of Claim 83, wherein:
the deposited cladding material substantially covers the device end face; and
the deposited waveguide core material extends upward from a proximal end of the waveguide core away from the substrate.

112. **(new)** The method of Claim 83, further comprising forming an optical coating between the device end face and the end-coupled waveguide.

113. **(new)** The method of Claim 83, wherein the end-coupled waveguide includes a dual-core segment.

114. **(new)** The method of Claim 83, wherein the device end face is non-normal with respect to optical propagation along the device waveguide segment.

115. **(new)** The method of Claim 83, wherein multiple optical devices are formed concurrently on a common device substrate wafer, and multiple corresponding end-coupled waveguides are formed concurrently on the common substrate wafer, and further comprising dividing the common substrate wafer into multiple device substrates.

116. **(new)** A method, comprising:

forming a semiconductor optical device on a device substrate, the optical device including a device waveguide segment terminating at a device end face;

depositing waveguide cladding material on the substrate and the device end face so that the cladding material substantially covers the device end face and forms a waveguide lower cladding layer;

masking the lower cladding layer, leaving unmasked that portion of the waveguide cladding material covering the device end face;

forming a substantially flat upper surface of the lower cladding layer and exposing an upper portion of the device end face by removing the unmasked portion of the waveguide cladding material until it is about the same thickness as the lower cladding layer and thereby forms a portion thereof;

de-masking the lower cladding layer;

after de-masking the lower cladding layer, depositing waveguide core material over the lower cladding layer so as to form a waveguide core; and

depositing waveguide cladding material over the waveguide core material and lower cladding layer so as to form a waveguide upper cladding layer,

wherein:

the lower cladding layer, the waveguide core, and the upper cladding layer form an end-coupled planar optical waveguide on the device substrate end-coupled at its proximal end to the device waveguide through the device end face;

deposited waveguide core material extends upward from a proximal end of the waveguide core away from the substrate; and

the upward-extending waveguide core material at the proximal end of the waveguide core is deposited on the exposed upper portion of the device end face.

117. **(new)** The method of Claim 116, wherein multiple optical devices are formed concurrently on a common device substrate wafer, and multiple corresponding end-coupled waveguides are formed concurrently on the common substrate wafer, and further comprising dividing the common substrate wafer into multiple device substrates.

118. **(new)** A method, comprising:

forming a semiconductor optical device on a device substrate, the optical device including a device waveguide segment terminating at a device end face;

depositing waveguide cladding material on the substrate and the device end face so that the cladding material substantially covers the device end face, the waveguide cladding material deposited on the device substrate and on the device end face being at least as thick as the device waveguide segment;

forming a substantially flat waveguide cladding material upper surface substantially flush with an upper surface of the device waveguide segment by removing waveguide cladding material by chemical-mechanical polishing;

forming a substantially flat lower cladding layer and exposing an upper portion of the device end face by removing waveguide cladding material by cladding-material-specific etching,

depositing waveguide core material over the lower cladding layer so as to form a waveguide core, deposited waveguide core material extending upward from a proximal end of the waveguide core away from the substrate; and

depositing waveguide cladding material over the waveguide core material and lower cladding layer so as to form a waveguide upper cladding layer,

wherein:

the lower cladding layer, the waveguide core, and the upper cladding layer form an end-coupled planar optical waveguide on the device substrate end-coupled at its proximal end to the device waveguide through the device end face;

deposited waveguide core material extends upward from a proximal end of the waveguide core away from the substrate; and

the upward-extending waveguide core material at the proximal end of the waveguide core is deposited on the exposed upper portion of the device end face.

119. **(new)** The method of Claim 118, wherein multiple optical devices are formed concurrently on a common device substrate wafer, and multiple corresponding end-coupled waveguides are formed concurrently on the common substrate wafer, and further comprising dividing the common substrate wafer into multiple device substrates.